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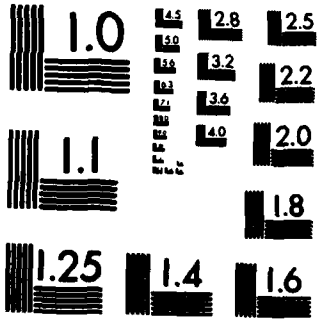

OPTIMUM DESIGN AND AUTOMATED DYNAMIC ANALYSIS OF FLEXIBLE MECHANISMS

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DECEMBER 10, 1984

U.S. ARMY RESEARCH OFFICE

GRANT NO. DAAG29-80-K-0096

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PROBLEM STATEMENT

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→The primary aim of the project was a thorough understanding and analysis of conditions of dynamic instability in flexible components of mechanisms and robots. Dynamic instability characterizes the behavior when amplitude of vibrations have a tendency to become unbounded with the passage of time. Other aims of the study included the optimal design of mechanisms on the basis of felxibility and control of stresses and deflections.←

SUMMARY OF RESULTS

The basis for the analysis is the conservation laws of linear and angular momenta together with the continuity requirements for forces and couples at the joints of the mechanism. The critical conditions for the onset of instability are determined on the basis of the linearized equations. Typically, these form of system of differential equations with periodic coefficients to which the classical Floquet theory and the modern developments based on the work of V.V. Bolotin may be applied.

Results of the stability analysis lead to the identification of critical values of geometry, speed and material properties that will cause instability. This type of the analysis have been carried out for the four-bar and slider crank mechanism. The former has been submitted for publication and the latter is being completed.

During a part of the project attention was given to the question of optimum design of mechanisms. Results were obtained on the basis of components which are fully stressed at the geometric boundaries and with controlled deflections. The method was illustrated for the case of steadily rotating slider crank mechanism. Parametric results indicated

the dependence of the stresses, link sizes and energy losses with axial coordinates, angular speed and geometrical aspect ratio of the mechanism.

LIST OF PUBLICATIONS

1. "Stability of Motion of Elastic Planar Linkage with Application to Slider Crank Mechanism," ASME Journal of Mechanical Design, Vol. 104, October 1982, pp. 698-703.
2. "Dynamic Instability of Elastic Coupler of a Four-Bar Mechanism," with M.C. Constantinou, ASME Paper No. 82-DET-6.
3. "Fully Stressed Deflection-Limited Design of Planar Mechanism," with G.O. Amazigo, ASME Paper No. 82-DET-23.
4. "Fully Stressed Optimum Design of Flexible Mechanisms," Proceedings of the Sixth World Congress on Theory of Machines and Mechanisms, December 1983, pp. 422-423.
5. "A Nonlinear Eigenvalue Problem in Elastic Stability," with C. Younis, Proceedings of the Second Army Mathematics Conference, May 1984, Troy, New York.
6. "Dynamic Instability of the Flexible Coupler of a Four-Bar Mechanism," with C. Younis, Proceedings of the Second Army Mathematics Conference and submitted to ASME Journal of Mechanisms, Transmissions and Automation in Design.

PERSONNEL

During the period of the project the following were associated either continuously or intermittently with the project and supported by it.

1 - M.C. Constantinou	M.S. - Jan. 1981 Ph.D. - June 1981
2 - J.R. Yeh	Ph.D. Expected June 1985
3 - C. Younis	M.S. - Jan. 1982 Ph.D. Expected June 1985
4 - H. Diken	Ph.D. Expected June 1985
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Dynamic Instability, Felxible Mechanisms

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Flexible Mechanisms such as slider crank and four-bar mechanisms are modeled and their dynamic instability and optimum design analyzed. → 6p

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